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CATS EYES ADJUSTMENT PROCEDURES

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Night vision goggles (NVGs) have been employed in a variety of aircraft for over 20 years; however, only recently has their application begun in fighter/attack aircraft. Research accomplished by the Night Vision Programs Office at the Aircrew Training Research Division of the USAF Armstrong Laboratory demonstrated the loss of NVG performance resulting from improper goggle adjustments. This report describes correct adjustment procedures for the CATS EYES NVG system currently being used by USAF, USN, and USMC fighter/attack pilots. The procedures described were developed so aircrews could take advantage of the adjustments available on the NVGs. Additionally, image descriptions are given to help aircrews evaluate NVG performance. Information on the necessary equipment/space needed for proper evaluation is also included.

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PREFACE

This work was conducted at the Armstrong Laboratory, Aircrew Training Research Division (AL/HRA) at Williams Air Force Base, AZ, by the University of Dayton Research Institute (UDRI). AL/HRA conducts visual training effectiveness research in support of aircrew training technology. One entity of this effort is a night vision training research program.

UDRI, working under Contract F33615-90-C-0005, is developing prototype instructional media and courseware to be used in aircrew night vision goggle (NVG) training. This report contains instructions for Air Force, Navy, and Marine Corps pilots to use in properly adjusting CATS EYES NVGs to maximize optical performance. The laboratory contract monitor was MS Patricia A. Spears and the effort was managed under Work Unit 1123-03-85, Flying Training Research Support.

The author would like to thank Col W.E. Berkley and Capt G.M. Fiedler for their technical assistance and Ms M.E. McConnon for her creative abilities in assembling this report.

CATS EYES ADJUSTMENT PROCEDURES

INTRODUCTION

Night vision goggles (NVGs) have become an integral part of night operations in many rotary- and fixed-wing aircraft. Properly fit and adjusted, they dramatically enhance night vision. However, improper adjustment can severely degrade visual acuity. While NVGs are not hard to use, you need to understand their design characteristics to get the most out of them. This report presents the basics of NVG preflight adjustment procedures for the CATS EYES system. With minor changes, these procedures can also be applied to other NVG systems.

NVG COMPONENTS

CATS EYES NVGs consist of two components: the mount assembly and the binocular assembly (Fig. 1).

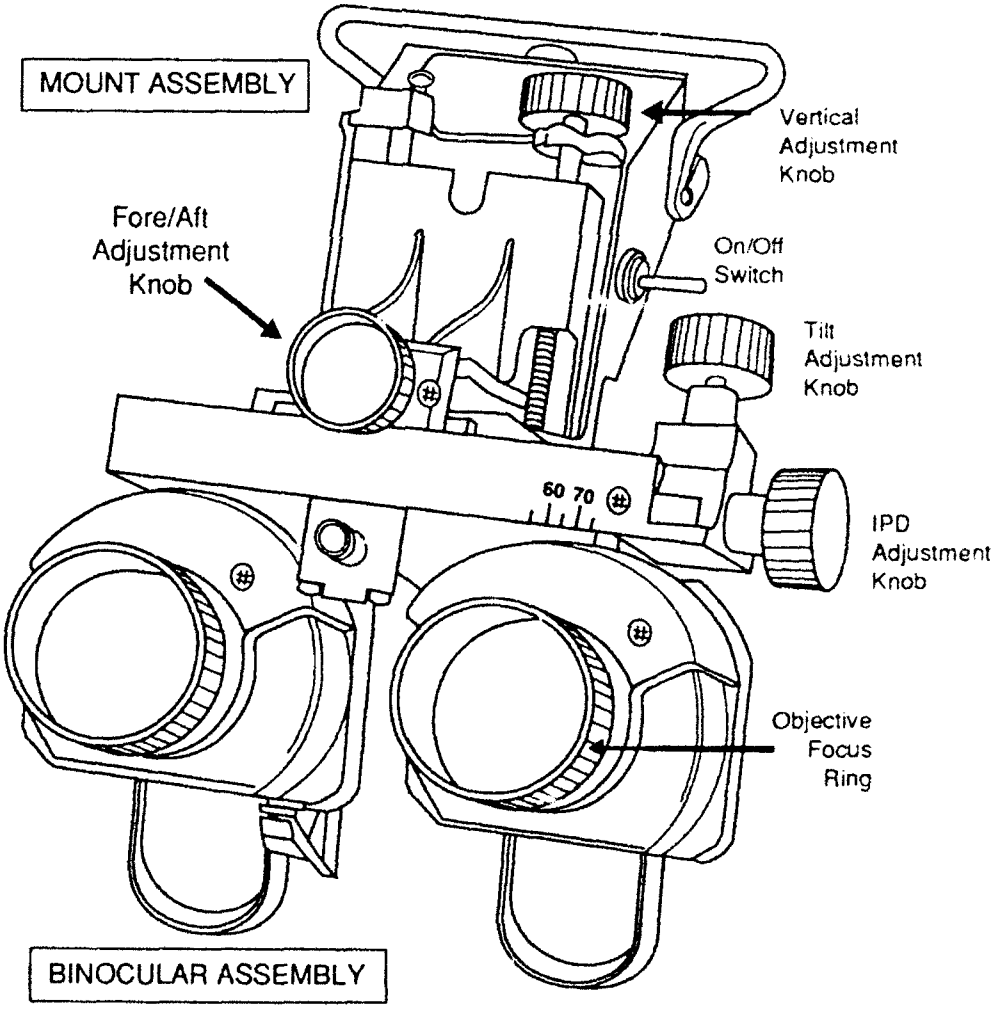

Figure 1
CATS EYES Components

The Mount Assembly

The mount assembly (Fig. 2) is secured to the helmet and holds the binocular assembly in front of the eyes. The assembly contains the following adjustments/subcomponents:

Vertical Adjustment Knob. Moves the binocular assembly up and down.

Quick Release Lever. Used to release the goggles from the mount by grasping and pulling forward.

Battery Compartment. Contains room for two batteries, either of which supplies enough power to operate the NVGs.

Batteries. Uses 2 half-AA size lithium batteries. Either battery supplies enough power to operate the NVGs.

WARNING

1. **Observe basic battery safety to help prevent any potential problems. For example, extra batteries should be carried in a small resealable plastic bag to prevent contact with metal objects such as loose change, car keys, etc. Do not heat, puncture, disassemble, short circuit or attempt to recharge the batteries.**
2. **One safety feature of the lithium battery is a built-in safety vent around the battery's casing. This vent allows the battery to release gas pressure in the event that a malfunction forces that pressure too high. Venting may be sensed through smell, the sound of gas escaping, or through irritation of the eyes. When safety vents have operated, batteries must still be handled with care when removing them from the NVGs.**
3. **Immediately turn off the equipment if battery compartment becomes hot to the touch. Allow the batteries to cool one hour before removing them.**

ON/OFF Switch. The battery compartment contains a three-position switch: ON (ASR), OFF, ON. The ON (ASR) position (up) selects the upper battery, turns on the NVGs, and engages the auto scene reject (ASR) function. The ON position (down) selects the lower battery and turns on the NVGs without engaging ASR. Due to possible malfunction of the ASR circuitry, the down position should be selected as the primary and the up position as the secondary selection when ASR is not installed on the aircraft or when it is not being used.

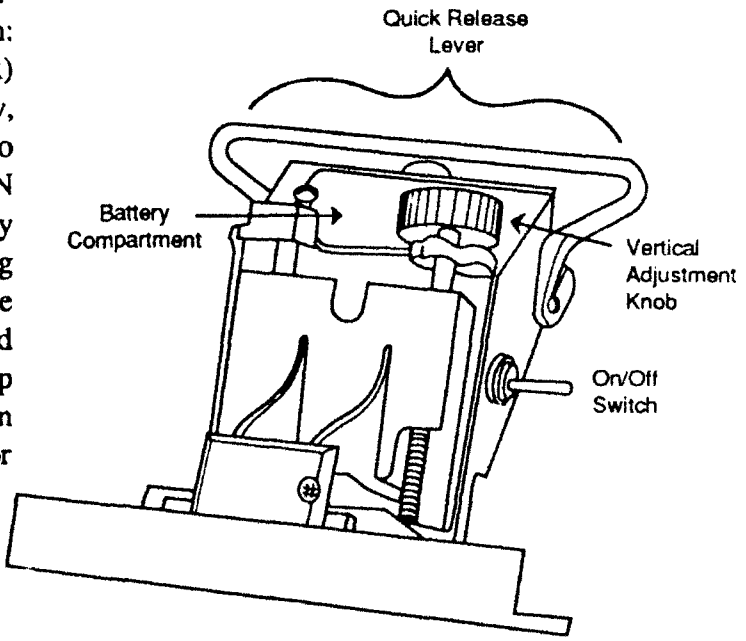

Figure 2
CATS EYES Mount Assembly

The Binocular Assembly

The binocular assembly (Fig. 3) contains the optical elements of the system. The assembly contains the following adjustments:

Fore and Aft Adjustment. Moves the entire binocular assembly toward or away from the eyes.

Tilt Adjustment. Allows wearer to rotate the binocular assembly.

Interpupillary Distance (IPD) Adjustment. Allows wearer to adjust for the distance between the eyes.

Objective Focus Ring. Focuses the goggles for distance.

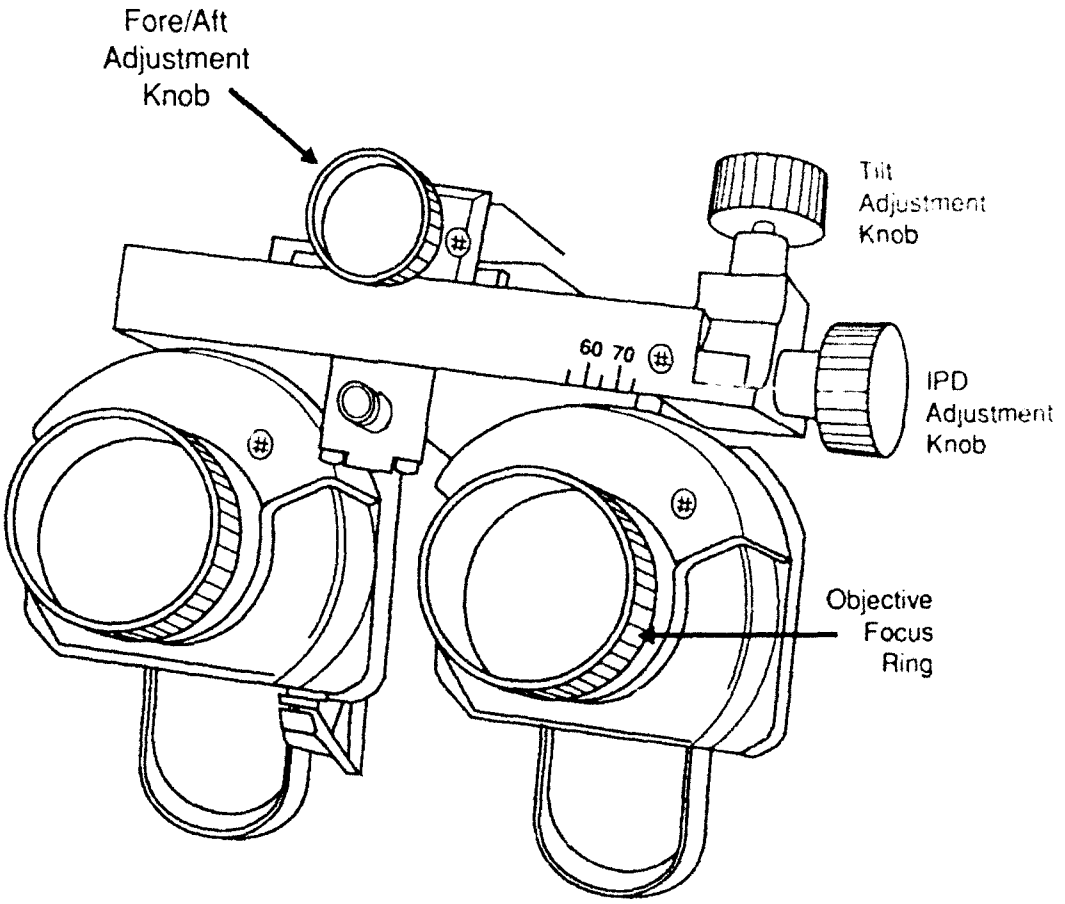

Figure 3
CATS EYES Binocular Assembly

ADJUSTMENT PROCEDURES

Adjustment procedures will take place at a 20-feet eye lane using a resolution chart illuminated by an appropriate source. I recommend that the VisTech 100% contrast NVG resolution chart be used. See page 8 for details on how to acquire a resolution chart and who to contact for information on eye lane and illumination source construction. The purpose of using the NVG eye lane is two-fold. First, it provides a place to adjust your NVGs. Second, it checks the performance of the device itself. The adjustment procedures are divided into three parts: (a) preflight procedure, (b) alignment procedure, and (c) focusing procedure. The alignment procedure is necessary because the design of the NVG provides the best performance ONLY when the optical axis of the device is aligned with the visual axis of the eye as shown in Figure 4. The alignment procedure should be performed before the focusing procedure to prevent degradation in performance caused by alignment errors.

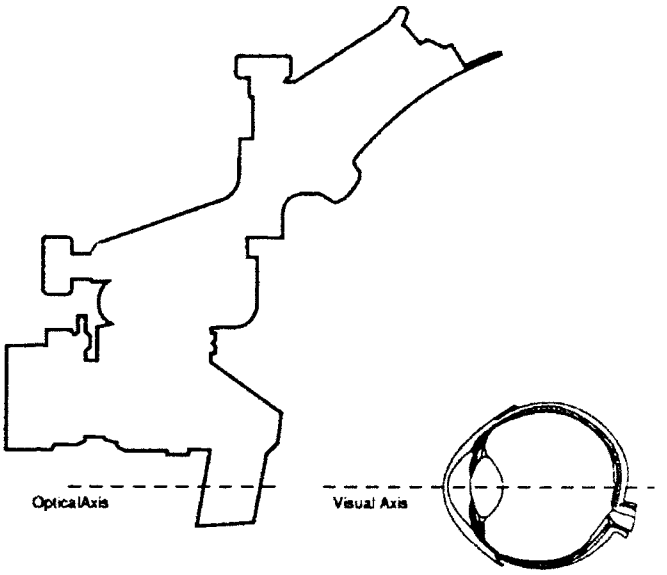

Figure 4
Alignment of Optical Axes

Preflight Procedures

Perform the following procedures prior to donning the NVGs in the eye lane:

Inspect Helmet and Helmet Bracket. Inspect the helmet and helmet components for any signs of excessive wear. If the helmet has an integrated nape/chin strap, ensure it slides freely. Inspect the helmet bracket for looseness and damage. There are a number of different helmets being used with CATS EYES. It is important that you know your helmet well and understand how the bracket is attached. An improperly positioned bracket will make it impossible for you to achieve maximum performance and field of view regardless of how much adjusting is accomplished.

Inspect Device. Check the overall condition and security of the goggles. Make sure all the knobs work properly and components move freely and smoothly. Check for loose parts and frayed wiring.

Clean Lenses. Inspect and clean the lenses. Always use lens paper to prevent scratching the lens surfaces. Dirty optics can degrade performance by up to 30% (as measured in the NVG Test Lane at the Armstrong Laboratory, Williams AFB, AZ).

Set IPD. A flight surgeon or optometrist should accurately measure your IPD. However, a temporary way to measure IPD is for someone to take a millimeter ruler and measure the distance between your pupils as you look over their shoulder at a distant object. The IPD will usually be between 55-75 mm. The IPD scale on the front of the NVGs may not be accurate. To ensure an accurate IPD setting, use a millimeter ruler and set the IPD by measuring from the outside of one monocular to the inside of the opposite as shown in Figure 5. Once the proper IPD setting has been set, the scale can be checked for accuracy. Even if the scale is inaccurate, the number indicated can be used as a gauge for rechecking in the cockpit.

Adjust Eye Relief. Position the binocular assembly as far forward (away from the eyes) as possible.

Center Tilt. Set the tilt adjustment to the centered position.

Adjust Vertical. Set the binocular assembly to a position centered between the highest and lowest limits.

Load Battery Compartment. Ensure the switch is in the OFF position before loading the batteries.

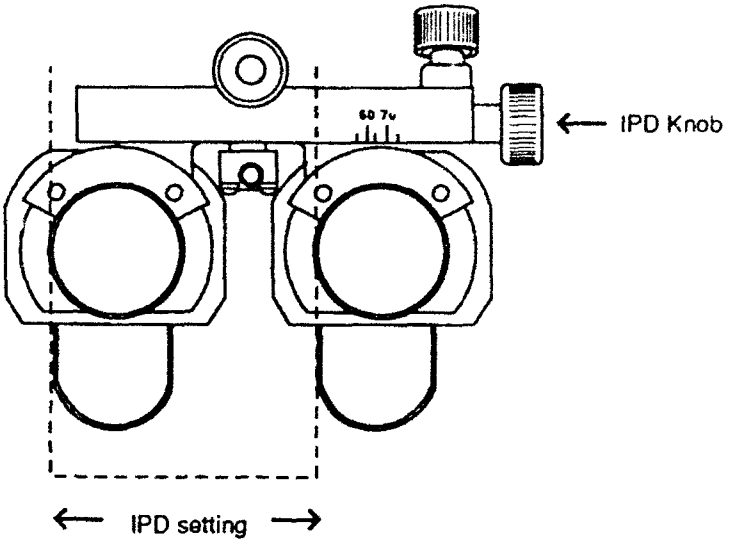

Figure 5
Setting the IPD Correctly

Attach NVGs to Helmet Bracket. The final check before entering the eye lane is to ensure the NVGs fit properly in the helmet bracket. Practice inserting the mount into the bracket and releasing the NVGs via the quick release several times before donning the helmet. Lastly, don the helmet, adjust the chin/nape strap, and attach the NVGs. Now practice removing and attaching the NVGs while the helmet is donned. If possible, also attach your oxygen mask and adjust it to the normal wearing tightness. This ensures you will adjust the NVGs with the helmet in the operational position. Not doing so may require some final adjustments after putting on the mask in the cockpit. Remember, it is a snug and properly fitted oxygen mask that is the greatest help in keeping the helmet from rotating forward while pulling Gs. Once the helmet and NVGs are donned and you are comfortable with attaching and removing them, proceed to the eye lane.

Alignment Procedures

Once you are in the eye lane with your helmet and NVGs donned, turn the lights off. Now turn on the NVGs.

WARNING

DO NOT TURN ON NVGs IN A LIGHTED AREA.

A REDUCTION IN THE LIFE OF THE INTENSIFICATION TUBES WILL RESULT.

Stand at the 20-feet line and look at the resolution chart. Bring it into gross focus using the focus adjustment. This will provide something to use as a guide for properly aligning the optical axis. Do not attempt to fine focus until after performing the following alignment steps:

Align Vertical. Adjust the vertical position of the binocular assembly using the vertical adjustment knob. The combiners should be directly in front of the eyes.

Adjust Tilt. Adjust the tilt to maximize the sharpness of the image. Minor adjustments to both vertical and tilt adjustments will need to be made together as the image is sharpened.

Check IPD. Due to the combiner design, the lower edges of the image are clipped with the resultant image not being a perfect circle (Fig. 6). Should the images not be overlapped to form a single image, make very small IPD adjustments in an attempt to correct the problem. DO NOT MAKE LARGE IPD CHANGES. Improper IPD adjustments can result in loss of visual acuity and/or severe headaches. If minor IPD adjustments do not result in a single image, attempt to form one by moving the helmet on your head. If this works it indicates the NVG bracket to be incorrectly placed. This may require a correction by maintenance prior to flight.

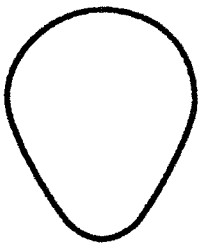

Figure 6
CATS EYES Image Shape

Adjust Eye Relief. Adjust the eye relief to obtain maximum image field of view (FOV) without obstructing vision around the goggles. Placing the combiners 25 mm (approximately one inch) from your pupil will ensure maximum FOV.

Evaluate Image. There should be no shading in any part of the display. A rule of thumb is to adjust toward any shading present. If the shading cannot be eliminated, there may be a problem with the helmet bracket placement. In this case, have maintenance check the bracket position.

Focusing Procedures

Make sure you are at the 20-feet line from the resolution chart. Focus on the test patterns on the chart as you adjust the focus to get the sharpest resolution. It is easiest to start with the largest test patterns and fine-tune your way to the smaller patterns. The objective is to be able to tell whether the lines are horizontal or vertical.

Focus Using Objective Ring. Since you are to focus one tube at a time, cover one of the tubes with a free hand being careful not to touch the lens, or close one eye. Focus using the objective ring until you can resolve as many of the patterns on the chart as possible. **Note:** The tilt control is the most sensitive in fine tuning and obtaining the best visual acuity. However, in obtaining the best visual acuity, some FOV may be lost. A portion of the FOV may be regained by readjusting with the vertical control. Practice is required to accurately and consistently obtain best performance while minimizing FOV loss.

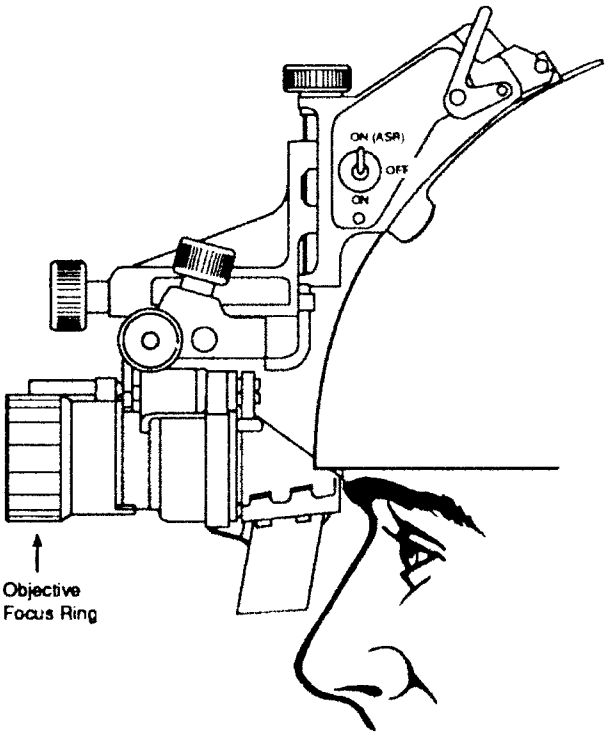

Figure 7
CATS EYES Objective Focus Control

Repeat Above Step . Focus the other tube using the same procedures. Do not be alarmed if one tube performs slightly better than the other. Differences frequently exist between the two tubes.

Check Performance. Evaluate visual acuity Use Table 1 to determine acuity level if using the Air Force resolution chart (see Fig. 8). Acuity should be at least as good when viewing the image with both tubes as it is when viewing the image in each tube alone. It is recommended that the minimum acceptable performance be 20/40 unless modified by unit regulations.

Table 1 Visual acuity determination using the USAF NVG resolution chart

# Correct	Visual Acuity	# Correct	Visual Acuity
9 of 9	20/35 or better	4 of 9	20/70
8 of 9	20/40	3 of 9	20/80
7 of 9	20/45	2 of 9	20/90
6 of 9	20/50	1 of 9	20/100
5 of 9	20/60	0 of 9	????

Evaluate Image. Several types of NVG image peculiarities exist. Most can be seen while evaluating performance in the eye lane. The most common types are as follow:

Shading. Appears as a dark area along the edge of the image. Attempt to eliminate shading by readjusting the controls. If shading continues, have maintenance check for proper bracket position on the helmet. If the problem cannot be corrected, do not use the NVG.

Edge Glow. Appears as a bright area along the outer edge of the image. Edge glow is usually the result of an incompatible light source. If noted, simply move your head or cup your hand around the periphery of the objective end of the NVG. If the edge glow does not disappear, do not use the NVG.

Bright Spots. Constant or flickering bright spots anywhere in the image. Hold one hand in front of the objective lens. If bright spots are still present and they degrade the image and/or are distracting, do not use the NVG.

Flickering. The NVG image from either or both tubes may flash or flicker at various rates. The effect may occur at varying illumination levels. If more than one flicker is noted, do not use the NVG.

Scintillation. Sparkling effect seen in the image under low illumination conditions. This results from the gain being driven very high and is a normal finding. It can be used to note a decrease in overall illumination caused by such things as worsening weather conditions.

Honeycombing. Pattern in image resulting from the fiber optics. It is most often seen in high light level conditions. If it is obvious or distracting under normal conditions, the NVG should not be used.

Distortion. Optical bending of a viewed object. Move your head back and forth rapidly in the eye lane keeping the chart in the field of view. If distortion is present and it is deemed likely to interfere with normal operations, do not use the NVG.

Veiling Glare. Caused by dirty, chipped, or scratched lenses, resulting in scattered light at certain angles. If it interferes with normal operations, do not use the NVG.

Dark Spots. There is a specification that limits the size, location, and number of dark spots on the NVG image. If dark spots are noted, check with maintenance to ensure that specifications are met.

Note Settings. Before leaving the eye lane, note the IPD setting that is correct for you with this set of goggles. You will need to recheck this setting aboard the aircraft before donning the NVGs. This recheck ensures the setting was not accidentally changed during transport.

CAUTION

TURN NVGS OFF PRIOR TO TURNING ON EYE LANE LIGHTS AND/OR LEAVING THE EYE LANE

In-Aircraft Procedures

Before donning NVGs in the aircraft, confirm that the IPD setting is the same setting used in the eye lane.

Since the device was focused at 20 feet in the eye lane, you will need to refocus to infinity. To refocus, pick a clearly defined object at least 75-100 feet distant, preferably one with vertical and horizontal edges or features. Avoid focusing on noncompatible lights because the halos they create do not allow for an accurate focus. Refocus ONLY using the objective focus ring.

Practice emergency removal of the NVGs several times before takeoff.

During flight, you may need to make minor adjustments to vertical and horizontal alignments due to helmet settling and rotation. Avoid corrections to tilt if possible as there is no way to accurately assess NVG performance in flight, and tilt has a pronounced effect on performance.

CAUTION

DO NOT CHANGE IPD SETTING DURING FLIGHT

SUPPORT ISSUES

Resolution Chart. The 100% resolution chart (Fig. 8) designed by the Armstrong Laboratory's Visual Display Systems Branch at Wright-Patterson AFB, OH, is recommended for use. It can be acquired on a GSA order (Product No. NVG-3335-100A) from VisTech Consultants (phone 1-800-847-8524).

Eye Lane and Illumination Source. It is imperative that eye lane and illumination source instructions be followed accurately. This will ensure proper NVG focusing and evaluation. For proper instructions, contact either the USAF Night Vision Programs Office of the Aircrew Training Research Division of Armstrong Laboratory at Williams AFB, AZ (DSN 474-6561, COMM (602) 988-6561) or Marine Air Wing Training Squadron One (S-5) at MCAS Yuma, AZ (DSN 951-3572, COMM (602) 341-3572).

Preflight and Adjustment Quick Reference. An abbreviated set of preflight and adjustment instructions are attached at the end of this document (Appendices A and B). Place them in an area easy to see and use, near where the NVGs are issued.

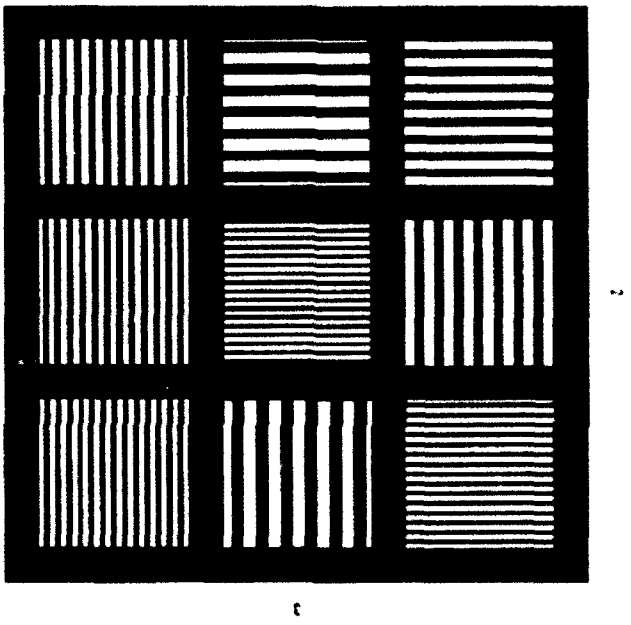

Figure 8
USAF NVG Resolution Chart

Appendix A

CATS EYES PREFLIGHT PROCEDURES

1. HELMET AND HELMET BRACKET – Check for damage
2. DEVICE – Check components for damage and adjustment knobs for free movement
3. CLEAN LENSES – Use lens paper only
4. SET IPD
5. SET EYE RELIEF FULL FORWARD AWAY FROM EYES
6. CENTER TILT
7. SET VERTICAL AT CENTERED POSITION
8. LOAD BATTERIES – Ensure switch is off
9. ATTACH NVGS TO HELMET BRACKET AND CHECK FOR EASE OF REMOVAL

Appendix B

CATS EYES ADJUSTMENT PROCEDURES

1. ROOM LIGHTS – Off
2. GOGGLE POWER – On
3. NVG ALIGNMENT
   - Align vertical
   - Adjust tilt
   - Check IPD
   - Adjust eye relief
4. NVG FOCUSING
   - Focus using objective ring one eye at a time
   - Readjust tilt and vertical as necessary
   - Check performance using both eyes
   - Evaluate image
   - Note IPD setting

9 of 9 .....20/35 or better	4 of 9 .....20/70
8 of 9 .....20/40	3 of 9 .....20/80
7 of 9 .....20/45	2 of 9 .....20/90
6 of 9 .....20/50	1 of 9 .....20/100
5 of 9 .....20/60	0 of 9 .....????

5. IN-AIRCRAFT PROCEDURES
   - Confirm IPD setting
   - Refocus to infinity
   - Practice emergency removal